

Stellio sacra (Smith 1935) - a Distinct Species of Asiatic Rock Agamid from Tibet†

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Abstract. -An examination of the type series of *Agama himalayana sacra* Smith (1935) and new material collected in Tibet in 1988 has shown that this form should be considered a distinct species. In following the recent revision of the genus *Agama* (Moody 1980), *Stellio sacra* is included in the genus with all other Asiatic rock agamids.

Key Words: Reptilia, Sauria, Agamidae, *Stellio sacra*, Tibet, systematics, distribution.

Introduction

Four agamid lizards were collected at the beginning of the 20th Century near Lhasa, Tibet. They were described in a short account by Smith (1935) as a subspecies of the Himalayan rock agamid *Agama himalayana sacra*.

The examination of these type specimens and new material collected in Lhasa and the vicinity of Lhasa, Tibet in 1988 by the third and fourth authors, led us to the conclusion that it is not a subspecies of *Stellio himalayanus*. Furthermore it is not a member of the *Stellio himalayanus* species complex which includes *Stellio badakhshanus*, *Stellio chernovi*, *Stellio himalayanus*, and *Stellio stoliczkanus*. The results of the examination of the agamids from Lhasa, Tibet confirm the opinion of Ananjeva et al. (1981) that *Stellio sacra* should be elevated to full specific status.

According to the present revision of the genus *Agama* (Wermuth 1967) into *Agama*, *Stellio* (Moody 1980; Sokolovsky 1975, 1977) *Trapelus*, *Psuedotrapelus*, and *Xenagama* (Moody 1980) the lizards examined from Tibet should have the generic name, *Stellio*.

Methods

To the best of our knowledge all specimens housed outside the Peoples Republic of China were examined. Of the four specimens in the type series, one lectotype and two paralectotypes are housed at the British Museum (Natural History) [BMNH], and one paralectotype is housed at the Indian Museum, Calcutta (Zoological Survey of India [ZSI]). Thirteen additional specimens were collected during the 1988 joint Chengdu Institute of Biology - University of California Expedition and are housed at the California Academy of Sciences (CAS).

Stellio sacra (Smith 1935), new combination

Known Material

Material Examined:

Lectotype: BMNH 1946.8.28.57 (formerly 1904.12.28.1) [Fig. 1.]
Locality: Near Lhasa, Tibet.

Paralectotypes: BMNH 1946.8.28.58, BMNH 1946.8.28.59 [Fig. 2], and ZSI 15740 [Fig. 3]. **Locality:** near Lhasa, Tibet.

CAS 170545. **Locality:** Elev. 3740 m, Sera Monastery, Lhasa (29° 39' N 91°

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FIG. 1. Lectotype of *Stellio sacra* BMNH 1946.8.28.57 (formerly 1904.12.28.1).

Sera Monastery, Lhasa (29° 39' N 91° 06' E), Lhasa Municipality, Xizang (Tibet) Autonomous Region, China. Collected by: T. J. Papenfuss and R. Macey. Date: 24 Sept., 1988.

CAS 170546-53. Locality: Elev. 3700 m, at base of mountains approx. 3 km WNW (airline) of the Potala Palace, Lhasa (29° 39' N 91° 06' E), Lhasa Municipality, Xizang (Tibet) Autonomous Region, China. Collected by: CAS 170546-49 R. Macey and T. J. Papenfuss, and CAS 170550-53 T. J. Papenfuss and R. Macey. Date: 25 Sept., 1988.

CAS 170554-57. Locality: Elev. 3990 m, 52.4 km south of Yangbajan (30° 13' N 90° 25' E), also at km 1900.8 from Xining, on the Xining-Golmud-Lhasa Rd., Lhasa Municipality, Xizang (Tibet) Autonomous Region, China. Collected by: CAS 170554-55 R. Macey and T. J.

Papenfuss, CAS 170556-57 T. J. Papenfuss and R. Macey. Date: 27 Sept., 1988. (See Table 1).

Other Material.

Note that the following material is reported on in Hu et al. (1987) but no numbers or reference to a museum collection are mentioned. It is probable that all or most of these specimens are housed at the Chengdu Institute of Biology.

Three males, 3 females, and 3 juveniles. Locality: Bomi (29° 50' N 95° 45' E), Qamdo Prefecture, Xizang (Tibet) Autonomous Region, China.

Six males, and 12 females. Locality: Lhasa (29° 39' N 91° 06' E), Lhasa Municipality, Xizang (Tibet) Autonomous Region, China.



FIG. 2. Paralectotypes of *Stellio sacra* BMNH 1946.8. 28.58 and BMNH 1946.8.28.59.

Two males, 2 females, and 1 juvenile. Locality: Nyningchi (29° 32' N 94° 25' E), Lhasa Municipality, Xizang (Tibet) Autonomous Region, China.

Distribution

Stellio sacra as presently understood, is restricted to the river drainage of the Yarlung Zangbo in the Lhasa Valley, Xizang (Tibet) Autonomous Region, China (Fig. 4). Only four localities are known, all between 3000 and 4000 m. Populations occurring in the Kunlun Mountains of southern Xinjiang Uygur Autonomous Region, China were previously assigned to *Stellio himalayanus himalayanus*, however their present taxonomic position is uncertain.

Diagnosis: Rock agamid with flattened head and body which is typical for this lizard group. They are comparatively large

lizards with a snout-vent length of 120-150 mm and a tail length of 180-240 mm (Table 1).

Gular Sac seems to be developed to a greater degree than in other *Stellio*. Body scales are small and granular. The scales are not well differentiated. There is a very slight but noticeable nuchal crest on the head. It begins from the middle of the occiput and continues as a poorly differentiated vertebral stripe. The longitudinal rows of enlarged and feebly keeled scales on the vertebral region are arranged parallel to each other. There are neither groups of enlarged scales nor separate enlarged scales on the dorsal lateral regions.

The males have a large patch of callous scales on the belly. The annuli and segmentation of the scales on the basal quarter of the tail are not prominent. On the



FIG. 3. Paralectotype of *Stellio sacra* ZSI 15740.

lateral surface of the tail there are three to four annuli in each segment.

There is a small granular dark pattern on the back. The center of the back tends to have more black and toward the sides a dark golden brown dominates. The separate elements of this pattern are connected to heavily marked diffuse transverse stripes. The narrow stripes form two rows of the dark colored scales that continue from the neck to the tail. Overall the lizard is darkly colored but there are a few randomly scattered yellow blotches on the back (Fig.5). Juveniles are lighter in color tending more toward a dark golden brown with darker speckling all over the

back. The dark golden brown forms bands across the back which are offset at the spine.

Comparative Description

Stellio sacra differs from *Stellio himalayanus* and related forms in all the diagnosis characters. *Stellio sacra* is only similar in body size to *Stellio stoliczkanus* among the species examined. Other species are notably smaller (Table 1; Anderson and Leviton 1969; Ananjeva et al. 1981).

The body proportion data concerning *Stellio sacra* and the *Stellio himalayanus* species complex indicates small differences

TABLE 1. Characters of *Stellio sacra* specimens used for analysis.

	Sex/age	Body length	Tail length	Hind limb length	Rostrum to front margin of tympanum	Number of scales at midbody
Type specimens						
BMNH 1946.8.28.57	M	136	215	98.5	30.5	232
BMNH 1946.8.28.58	F	130	autotomized	92.0	27.6	230
BMNH 1946.8.28.59	subadult	74	146	48.5	17.0	225
ZSI 15740	F	124	182	83.5	26.6	-
CAS specimens						
170555	M	147	246	92.2	33.6	249
170554	M	145	233	98.0	31.2	240
170556	M	143	autotomized	89.0	30.3	250
170546	F	114	188	74.0	24.3	230
170547	F	100	185	67.2	21.9	245
170548	F	100	autotomized	66.8	21.0	247
170545	juv.	67.0	128	45.0	14.8	225
170549	juv.	72.5	142	52.0	16.1	256
170550	juv.	71.0	137	48.0	15.7	246
170551	juv.	75.5	155	54.0	16.5	250
170552	juv.	75.0	136	52.0	16.2	234
170553	juv.	66.3	132	48.0	15.4	248
170557	juv.	82.5	146	61.0	18.0	223

(Table 2). *Stellio sacra* has a shorter tail than *Stellio badakhshanus*, *Stellio chernovi*, and *Stellio himalayanus*.

One of the paralectotypes, a female (BMNH 1946.8.28.58), has a regenerated tail. The length of the regenerated tail after autotomy is about 80 mm which is rather great. The scales of the tail are mucronate, and the regular annular arrangement in the regenerated portion of the tail is disturbed.

Stellio sacra has a more similar head height index to *Stellio erythrogaster* and *Stellio lehmanni* than to *Stellio caucasicus* and *Stellio himalayanus* (Ananjeva 1981); i.e. the head is not so flat (depressed).

It is necessary to also remark about the differences in the structure of the digits in *Stellio sacra* and that of the specimens examined of *Stellio caucasicus*, *Stellio lehmanni*, and *Stellio stoliczkanus* of the same size. The digits, and especially the terminal phalanges, of *Stellio sacra* specimens are not round in their section as in the above group of species, but instead are compressed laterally.

The distinctive character of *Stellio sacra* pholidosis is its comparative homogeneity. The scales on the back, sides and belly are small. It has a considerably large scale count around the mid-body of 239 scales. The mid-body scale count of *Stellio badakhshanus*, *Stellio chernovi*, *Stellio himalayanus*, and *Stellio stoliczkanus* all do not exceed 180 scales. Such a large mid-body scale count is only observed in *Stellio nuristanicus*, which has from 230-248 mid-body scales. During this phase of our study two of the type specimens (Anderson and Leviton 1969) were examined.

The longitudinal rows of the enlarged poorly keeled scales are not arranged as the obvious "dorsal stripe," as typically observed in many other species of *Stellio*. The dorsal scales gradually decrease in size and degree of keeling, from the center of the back toward the small dorso-ventral scales. The ventral scales are smaller than the dorsal scales. The posterior margins of these scales slightly overlap the scales of the following row.

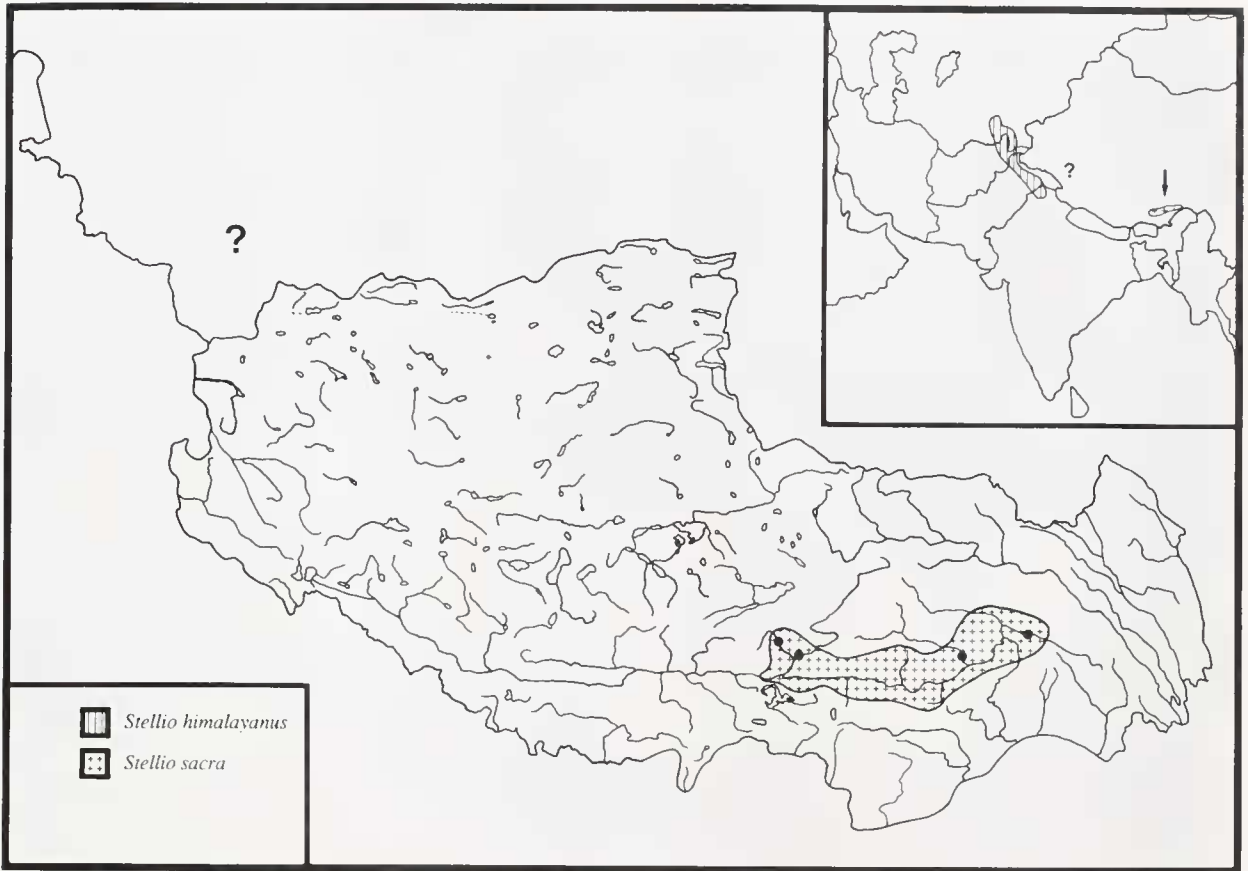


FIG. 4. Distribution of *Stellio himalayanus* and *Stellio sacra*. Question mark indicates Xinjiang Autonomous Region population of questionable taxonomic status.

The ventral head scales are also small and not regular. The size of these scales decreases from the nasal end toward the gular fold. On the sides of the head and on the neck are situated small groups of very strongly keeled spinose scales.

Stellio sacra has nostrils shaped longitudinally oval, similar to *Stellio chernovi* and *Stellio himalayanus*. Where as *Stellio agrorensis*, *Stellio melanurus*, *Stellio nuristanicus* and *Stellio tuberculatus* have round nostrils. *Stellio sacra* has a round tympanum.

In *Stellio sacra*, the scales of the upper surface of the fore and hind limbs are comparatively small, but their size is similar to the largest dorsal scales. These scales are strongly keeled. Single slightly enlarged scales are distinguishable from the

surrounding small scales. The scales on the base of the tail are keeled and mucronate, but to a smaller degree than for example in *Stellio himalayanus*.

The results of the comparative study of Asiatic rock agamids enables the typical distinguishing characters of *Stellio sacra* to be identified:

1. The small size of the scales.

2. The presence of a short nuchal crest made up of from two to three scale rows of slightly enlarged, narrow, keeled, dark colored scales. Such a nuchal crest is absent in *Stellio chernovi*, *Stellio himalayanus*, *Stellio stoliczkanus* and other species. A nuchal crest is noted however in *Stellio melanurus*, *Stellio nuptus*, *Stellio Stellio*, and *Stellio tuberculatus*.



FIG. 5. *Stellio sacra* from elevation 3990 m, 52.4 km south of Yangbajan (30° 13' N 90° 25' E), Xizang (Tibet) Autonomous Region, China.

3. The ends of the occipital (nuchal) and neck scales are directed backwards but not forward; the parietal scales are oriented in a laterocaudal direction.

4. The rows of the enlarged dorsal scales are parallel but do not meet as in species of the "*Stellio himalayanus*" complex.

TABLE 2. Comparative data on the relative proportions of the tail, limbs, and head of rock agamids of the genus *Stellio* (*S. sacra* and agamids of the *S. himalayanus* complex).

Species	n		tail length/ body length		hind limb length/ body length (%)		head length/ body length (%)	
	Male	Female	Male	Female	Male	Female	Male	Female
<i>Stellio sacra</i>	5	4	1.61	1.58	72.2	69.0	27.0	25.1
<i>Stellio stoliczkanus</i>	35	14	1.65	1.48	66.3	63.7	25.9	25.1
<i>Stellio himalayanus</i>	11	15	1.88	1.75	67.9	66.7	26.3	25.7
<i>Stellio badakhshanus</i>	3	1	1.72	1.67	76.0	70.0	27.3	26.2
<i>Stellio chernovi</i>	18	8	1.85	1.77	77.2	74.0	27.6	26.3



FIG. 6. Habitat of *Stellio sacra*, elevation 3990 m, 52.4 km south of Yangbajan (30° 13' N 90° 25' E), Xizang (Tibet) Autonomous Region, China.

5. In the region over the shoulders there are two arched diffuse rows of slightly enlarged mucronate (spinose) scales.

6. The absence of enlarged scales or regions of enlarged scales on the back of the body.

7. The upper head scales distributed between the nasal scales have a stretched shape. The length of these scales is twice the width as also in *Stellio agorensis*, *Stellio nuristanicus*, and *Stellio tuberculatus* where as the scales of *Stellio chernovi* and *Stellio himalayanus* have a roundish, polygonal shape.

8. Only a single row of small scales is noted between the suboculars and the supralabials. Other species have two to

five scale rows.

9. The scales of the back, shoulders, thighs and some parietal scales have an unusual microstructure. The margins of the scales are jagged resembling that of fringes. This character was also observed in *Stellio annectens*, *Stellio erythrogaster*, *Stellio melanurus*, and *Stellio nuptus*.

10. There is a patch of callous (granular) scales in the middle of the belly, which is large in males.

11. The males have a large patch of anal pores and from six to seven rows of callous scales before the cloaca.

Coloration

The dorsal coloration of the type

specimens consists of diffuse components, each scale is either totally dark or light in coloration. The parietal region and along the middle of the back (two scale rows of absolutely dark scales) are more dark in coloration. From the middle of the back to the sides there are light brown transverse stripes. This coloration is poorly developed in some specimens.

The subadult specimen has a similar small speckled pattern and in addition has alternating light and dark transverse stripes coming from the vertebral ridge toward the sides of the body. This pattern is similar to that of juvenile specimens of *Stellio tuberculatus*.

As far as we can tell from the available specimens of *Stellio sacra*, no contrasting pattern and coloration on the surface of the gular region, neck and nuchal region are noted. Such a contrasting pattern and coloration are typical for specimens of *Stellio himalayanus* and related species.

Natural History

Stellio sacra are common in the rocky hills surrounding the Lhasa Valley. They were seen only on slopes covered with large boulders (Fig. 6). Often a single adult male occupied a pile of boulders in association with several females and juveniles. *Stellio sacra* is an agile, alert species that is difficult to approach closely. The only other reptile that occurs on the rocky slopes is the gecko, *Cyrtodactylus tibetanus*. Another agamid, *Phrynocephalus theobaldi* is abundant on the sandy soil at the base of the rocky hills.

Discussion

The large review of the rich Indian fauna that Smith (1935) dealt with explains why the Sacred Agamid, *Stellio sacra*, was originally described as a subspecies of the Himalayan agamid, *Stellio himalayanus*. The study presented here concludes that *Stellio sacra* is not related to the *Stellio himalayanus* complex. On the other hand the above descriptions of the morphological characters do not allow an interpretation of the direct relation of *Stellio sacra* to such

species as *Stellio agrorensis*, *Stellio melanurus*, *Stellio nuptus*, and *Stellio tuberculatus*. The characters which enable us to bring together *Stellio sacra* and these species should be considered as plesiomorphic similarities. These characters are long limbs, the presence of a small gular sac and nuchal crest, the polyannular structure of the caudal segments, the juvenile color pattern, and so on. This assumption about a plesiomorphic condition is based on the idea that the oligomerization (decreasing of number of elements) of homologous organs (here pholidosis elements) is one of the main directions of agamid evolution (Dogel 1954).

Characters, such as the orientation of the scale axes in nuchal and neck regions and in parietal scales is also of great interest. It is suggested (Peters unpublished data) that the more common condition of the scale, i.e. the orientation of the point backwards, is typical not only for most of the species in the genus *Stellio* (including *Stellio sacra*), but also for the majority of agamids and lizards as a whole. Hence it is a plesiomorphic condition. The contrary direction, where the point of the scale is forwards, is observed in *Stellio melanurus*, *Stellio nuptus* and a number of African species. In accordance with Peter's point of view, this should be considered as an apomorphic condition. However there is a problem in interpreting such a character as the presence of the scales with the jagged margins. This scale structure is found in species with both types of scale orientation, including *Stellio sacra* as well as *Stellio erythrogaster*, *Stellio melanurus*, *Stellio nuptus* and the African species, *Stellio annectens*. The interpretation of such characters makes all possible explanations of the relationships of these species controversial.

These facts and the inability at this time to determine even a single obvious synapomorphy for all Asiatic rock agamids of the genus *Stellio* (with or without *Stellio melanurus* and *Stellio nuptus*) does not allow an acceptable phylogenetic relationship to be developed. This problem

TABLE 3. The distribution of the species in the genus *Stellio*.

Species	Distribution
<i>Stellio adramitana</i> (Anderson 1896)	Arabia
<i>Stellio agrorensis</i> (Stoliczka 1872)	Afghanistan, Pakistan, India
<i>Stellio annectens</i> (Blanford 1870)	Africa (Somalia, Ethiopia)
<i>Stellio atricollis</i> (Smith 1849)	Eastern and southern Africa
<i>Stellio badakhshanus</i> (Anderson and Leviton 1969)	Afghanistan
<i>Stellio caucasius</i> (Eichwald 1831)	Caucasus, Tadjikistan, Turkmania, Turkey, Iraq, Iran, Afghanistan, Pakistan
<i>Stellio chernovi</i> (Ananjeva, Peters, and Rzepakovsky 1981)	Tadjikistan, Turkmania, Uzbekistan
<i>Stellio cyanogaster</i> (Ruppell 1835)	Somalia, Ethiopia
<i>Stellio erythrogaster</i> (Nikolsky 1896)	Iran, Turkmania
<i>Stellio himalayanus</i> (Steindachner 1869)	Tadjikistan, Uzbekistan, Afghanistan, Pakistan, India
<i>Stellio lehmanni</i> (Nikolsky 1896)	Tadjikistan, Turkmania, Uzbekistan, Afghanistan
<i>Stellio melanurus</i> (Blyth 1854)	Iran, Pakistan
<i>Stellio microlepis</i> (Blanford 1874)	Iran
<i>Stellio nuptus</i> (De Filippi 1843)	Iraq, Iran, Afghanistan, Pakistan
<i>Stellio nuristanicus</i> (Anderson and Leviton 1969)	Afghanistan
<i>Stellio phillipsii</i> (Boulenger 1895)	Ethiopia
<i>Stellio sacra</i> (Smith 1935)	Tibet
<i>Stellio stellio</i> (Linnaeus 1758)	Greece, southwest Asia, northern Egypt
<i>Stellio stoliczkanus</i> (Blanford 1875)	Mongolia, China
<i>Stellio trachypleurus</i> (Peters 1982)	Ethiopia
<i>Stellio tuberculatus</i> (Hardwicke and Gray 1827)	India, Nepal, Afghanistan, Pakistan
<i>Stellio yemenensis</i> (Klauzewitz 1954)	Arabia
<i>Stellio zonorus</i> (Boulenger 1895)	Somalia

may be explained not only by the small sample size of *Stellio sacra* and the fact that many other forms are poorly studied but also by the obvious existence of parallel trends in different developmental lines within this lizard group.

In order to arrive at a more trust worthy hypothesis of the relationships of rock agamids, it is necessary to carry out biochemical investigations. The first preliminary results of such investigations are that of Joger and Arano (1987) and Ananjeva and Sokolova (in prep.). This type of data will be highly interesting to compare with the results of comparative morphological studies.

The distributional patterns of Asiatic rock agamids of the genus *Stellio* (Table 3) and their chorological isolation seems to support the idea that *Stellio* is a

monophyletic group. Rock agamids of the genus *Stellio* are distributed from Greece and the Nile River Delta in the west to the Gobi Altai of southern Mongolia, and the western deserts of China in the east. In the western part of this region, Greece to the Nile River Delta, *Stellio stellio* is found. The southern portion of this region from southwestern Iran to Pakistan *Stellio melanurus* and *Stellio nuptus* occur. These species are probably of African origin (Peters unpublished). In southern Iran and Afghanistan along with *Stellio melanurus* and *Stellio nuptus* also occur *Stellio agrorensis*, *Stellio badakhshanus*, *Stellio caucasius*, *Stellio erythrogaster*, *Stellio himalayanus*, *Stellio microlepis*, and *Stellio nuristanicus*.

The Asiatic rock agamids of the genus *Stellio sensu stricto* are absent from the mountainous regions of western Indostan

and the eastern portion of the Arabian Peninsula. They are also not found across the Red Sea in Ethiopia and Somalia. These areas are poorly studied herpetologically and it is possible that they do in fact occur in these regions.

The distribution of Asiatic rock agamids seems to be a single unit. Most problematic is the origin of such species as *Stellio melanurus*, *Stellio nuptus*, and *Stellio stellio*, which may be of African origin as it was already mentioned above.

It is possible that this assumption will be corroborated during further research in biochemical phylogeny. The preliminary results of Joger and Arano (1987) on *Stellio stellio* is a first step. The origin of the genus *Stellio* is interesting and the data about the early divergence of *Stellio* in *Stellio sensu stricto* (Asiatic species) and the *Stellio atricollis* species group from Africa and southern Arabia is useful (Joger and Arano 1987). It is possible that *Stellio* is a paraphyletic group of species. The Arabian - African species group is *Stellio adramitana*, *Stellio annectens*, *Stellio atricollis*, *Stellio cyanogaster*, *Stellio phillipsi*, *Stellio trachypleurus*, *Stellio yemenensis*, and *Stellio zonurus* (Table 3). These species are similar to the Asiatic species *Stellio melanurus* and *Stellio nuptus* in a number of characters. This allows an assumption that they are related.

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